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Electrical Resistance Measurements of Connector-Panel Interfaces

by

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Abstract

Reported are the resistivity measurements of selected materials and bulkhead feedthrough interfaces, procedures used in testing, and recommendations for optimum resistivity.

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1. Introduction

The purpose of this report is to indicate construction methods which would assure both vacuum and electrical-grounding integrity of the subminiature series A (SMA) vacuum bulkhead feedthrough connectors. This investigation was initiated in response to the finding that some of the connectors on the nonupsettable computer modules were not thoroughly grounded.

This report presents the results of resistivity measurements on several selected conducting panel materials and several configurations of feedthroughs. The information reported is organized into procedures used to acquire the data, test results, and recommendations. Specific recommendations are made for the best materials and parts to achieve low resistance and a hermetic seal. Also, designs are recommended for the O-ring and groove design on bulkhead hermetic feedthroughs.

2. Test Procedure

For the experiment, four plates were made, with each plate measuring about 5 in. square and 1/8 in. thick. Each plate was made of a different material type or coating: copper, aluminum with 0.0004 in. of copper plating, aluminum, and alodined* aluminum. Each plate had a 5/16-in.-diameter hole in the center through which was fitted a bulkhead feedthrough. The two feedthroughs used were the hermetically sealed type, with SMA-jack-to-SMA-jack, 50-ohm ends. One was passivated stainless steel (Omni spectra 2084-8001-92), and the other was gold-plated beryllium copper (Huber and Suhner 34 SMA 50-0-3/111). Measurements were made on each of the four plates using the two types of feedthroughs with rubber O-rings, with conductive O-rings, and without O-rings. The latter was used for reference only, since it does not provide a vacuum seal.

Alodining is a treating process on the surface of materials to prevent oxidation.

Figure 1 shows a wiring diagram of the experiment. The power supply was set to one ampere current for all measurements. Leads were connected from the power supply to one side of the feedthrough and to the corner of the test plate to provide a current path. A Keithley voltmeter was used to measure the voltage difference from a point on the connector to a point on the plate close to the connector. The connectors were repositioned in the plates several times and readings taken after each positioning; an average of these data was used to compile table 1. The measurements were in millivolts; using the formula $R = V/I$, we calculate and tabulate the resistance in milliohms.

3. Test Results

Table 1 shows the results of the experiment for the several material combinations. Note that the stainless-steel connector has a resistance of an average of 35 times that of the gold-plated connector. The reason for this is not obvious since stainless steel has a resistivity only moder-

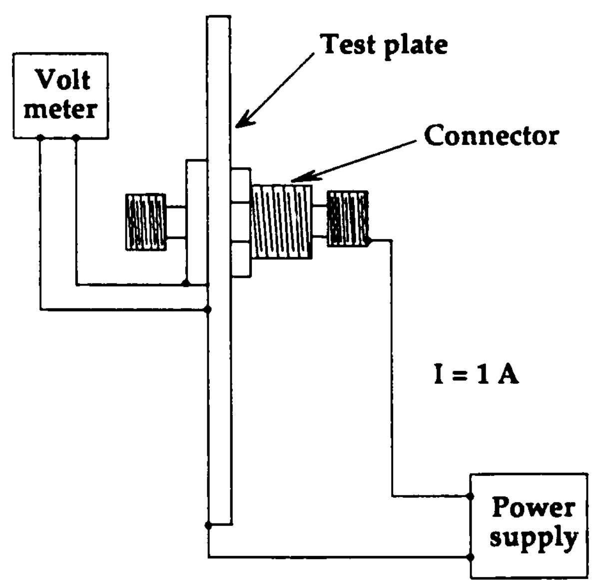

Figure 1. Wiring diagram on connector experiment.

Table 1. Results of Connector Experiments Using Several Material Combinations (All measurements are in milliohms)

Connector type	Copper-plate	Copper-plated aluminum	Aluminum plate	Alodined aluminum
Stainless steel with no O-ring	0.215	0.305	0.346	2.031
Gold-plated with no O-ring	0.006	0.009	0.021	0.036
Gold-plated with rubber O-ring*	0.013	0.021	0.039	0.059
Gold-plated with conductive O-ring**	0.004	0.006	0.016	0.021

**Rubber O-rings supplied by both connector manufacturers overfill the O-ring groove.*
***Conductive O-ring is properly sized for connector's O-ring groove.*

ately higher than copper. It is possible that some type of passivation is applied to the stainless steel which forms a partially insulating surface. The resistance was reduced by an average of 1.5 times, reaching its lowest value when conductive O-rings from Chomerics (Part No. 10-00-2253-1214) were used with the gold-plated connector. When the rubber O-rings supplied with the connector were used the resistance increased an average of 3 times that of conductive O-rings. This presumably was due in part to groove overfill, which did not allow the flange to make contact with the test plate; the O-rings supplied by the manufacturers were considerably oversized.

4. Recommendations

After measuring and calculating the area of the O-ring groove in both manufacturer's bulkhead feedthroughs, we found that there was insufficient groove area for the O-ring supplied. When there is groove overfill, stress fractures occur in the O-ring, leading to mechanical failure. Also, the groove-flange cannot come in contact with the plate material to provide a good electrical junction. The O-rings supplied with the feedthroughs for both brands were 0.301 in. inside diameter (ID) by 0.070 in. cross section (W). A solution would be to replace them with O-rings 0.295 in. ID × 0.059 in. W. This size does not overfill the groove, yet it provides enough squeeze to mechanically seal, based upon the requirements presented in *Parker's O-Ring Handbook.*

Alteration of the O-ring groove was considered, but insufficient feedthrough material was available to allow the supplied O-rings to be used.

We also see from the table that stainless-steel feedthroughs are highly inferior; it is, therefore, recommended that only gold-plated connectors be used, preferably with the conductive O-ring. Furthermore, it is recommended that aluminum panels with copper-plating in the connector contact area be selected as cost-effective.

Finally, as expected, alodine finish is unacceptable even though it is typically referred to as "conductive" by electroplating shops.